

Overview of a passive tracking index for monitoring wild canids and associated species

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Abstract

Population density estimates for many animal species are often difficult or expensive to obtain, and they rely on assumptions that, if violated, result in unmeasurable estimation errors. Density estimates also may be unnecessary for research or management purposes, because an index that tracks changes in a population within appropriate time and geographic constraints could provide the information necessary to make management decisions or to evaluate the impact of a control program. We review research on a passive tracking index where observations are made on a series of tracking plots placed on lightly used dirt roads. The number of sets of tracks (individual intrusions) are recorded for each species of interest on each plot on consecutive days. The mean number of intrusions over the plots is calculated for each day for each species. The index is the mean of the daily means. These design and measurement methods present valuable advantages over most traditional tracking plot methods. Because no scents or baits are used as attractants, no conditioning of animals to the plots biases the results. This also permits multiple species, predator and prey alike, to be simultaneously monitored. Using the number of animal intrusions as observations produces results that are far more sensitive to change than tracking surveys where only presence or absence of spoor are recorded for each plot. Of particular importance, the statistical properties inherent to this data structure permit calculation of standard errors, confidence intervals and statistical tests, without subjectively subdividing the data.

Introduction

A frequent problem in wildlife biology occurs when the population and/or density of the animal of interest is impossible to accurately assess with current methods, or the economic or logistical costs of doing such an assessment are prohibitive. In addition, the statistical theory used to produce density estimates usually requires fulfillment of assumptions that, when violated, result in estimates of questionable quality (see Leidlöff (1998) for an excellent examination of potential problems with capture–recapture methods and Burnham *et al.* (1980) for a similar discussion on line transect methods). Carnivores pose particular difficulties for assessing population status, as they are characterized by: relatively sparse populations; large home ranges

and movement patterns of individual animals; secretive behavior; occurrence in rough terrain; and difficulties in capture and observation (Pelton & Marcum 1977). Frequently, density estimates are unnecessary for research or management purposes, because an index that tracks changes in a population within appropriate time and geographic constraints can provide the information necessary to make management decisions or to evaluate the impact of a control program (Caughley 1977). Such an index should be simple and quickly applied in the field, while providing sensitivity to reflect population changes over time or space.

We have developed and refined a passive tracking index (PTI) that has been applied for monitoring wild canid populations in Australia and North America. The index may have applications for monitoring canid

(20 mm diameter \times 5 mm thick) was placed in the plot center. Discs were prepared in the laboratory prior to the field trial. Residual odors were removed from the plaster by placing them in a glass chamber that was continuously evacuated for 30 min. Then they were soaked in FAS for 60 min, removed, drained and sealed in bottles to await placement in the plots using tweezers or plastic gloves. Tracking plots were checked daily. Dingo responses to FAS (and buried meat plots, below) made it impractical to separate superimposed tracks (dingoes scratched, rolled, urinated and often wrecked the tracking plot), so no attempt was made to identify the number of intrusions by dingoes onto the plots. Plots were recorded as a positive or negative response for dingo activity.

Buried meat (BM) index. One piece (50–100 g) of fresh, boneless kangaroo meat was buried (5–10 cm) in the center of 1 m² of raked earth every 500 m on alternate sides of the road and 250 m from the nearest FAS plot. Burying the baits did not reduce the probability of discovery by dingoes, but deterred removal by birds and other non-target animals (Allen *et al.* 1989). Plot activity was assessed as for the FAS index, above (Allen *et al.* 1996).

Comparisons. The PTI (taken from plots spaced at 1 km on the same roads to which the FAS and BM plots were adjacent) resulted in substantially higher proportions of positive readings than for the FAS or BM indices (Allen *et al.* 1996). The BM index tended to have a response rate 2–3 times that for the FAS index, and the passive index had a response rate about 1.5 times that for the BM index and 3 times that for the FAS index. Correlation coefficients among the three indices were each >0.85 , indicating that the three methods maintained their relative response rates through time. The FAS disc appeared to attract to the plots only a small proportion of the dingo population potentially exposed. This comparatively low response rate for dingoes to the novel FAS attractant is consistent with the response reported for coyotes in the U.S.A. (Harris 1983) and suggests that dingoes exhibit a similar neophobic behavior inside their territories. Discounting any differences in magnitudes of odor plumes from the two attractants, and their respective presentation differences, the dingoes response to FAS and BM indicated they may be more likely to investigate a familiar food (kangaroo) than an unfamiliar odor.

Variations tested for the passive tracking index

Comparison of binary responses to measuring number of intrusions. Analyses of tracking plot data as a binary response (positive or negative) reduced sensitivity for detecting differences in dingo activity (Allen *et al.* 1996). Numbers of dingo intrusions on the plots were recorded, rather than just a positive or negative result, but with binary data it is possible that control could reduce the population, but surviving animals could provide no fewer positive responses. Theoretically, if the number of animals visiting the FAS and BM stations could have been recorded, then the sensitivity of the methods could have been improved. This loss of sensitivity is expected when information is reduced from a greater continuum to two options. (e.g., Engeman *et al.* 1989).

To specifically examine the sensitivity of this index versus using binary observations for each plot where only presence or absence of spoor are recorded, the Texas data from 1998 were used to conduct additional statistical tests for comparing pre-trapping data to post-trapping data (Engeman *et al.* 2000). First, mean daily proportions of plots positive for spoor pre- and post-trapping were compared. Pre- and post-trapping differences were still detected for both ranches, but not to the same degree of confidence (p -values increased by factors from 5 to 1500). Next, we considered what the result would have been if only the first day of data had been collected as presence-absence (binary) observations, pre- and post-trapping. The use of binary observations with only a single day of observation resulted in a further loss of sensitivity to change, with only one of the two ranches trapped in 1998 showing differences statistically (Engeman *et al.* 2000).

Alternative plot placement test. We examined the influence on index results of road usage or non-usage by the animals being monitored (Engeman unpublished data). This could have a bearing on the index values themselves, as well as on interpretations of the effects of population changes by one species on the populations of another species, especially when the two may use roads differently. In the Texas trial in 1999, paired tracking plots were created to examine how indices calculated from off-road plots compared to indices calculated from tracking plots placed as usual in the roads. At each road plot, another same-sized plot was located ≥ 30 m from the road on naturally occurring bare ground in natural habitat. The underbrush in that

part of Texas is dense and dominated by dense stands of woody (and thorny) shrubs and cacti. It appeared that most species used the dirt roads as travel ways, as only deer produced comparable index values from off-road plots. Most species for which indices were calculated from on-road plots produced too few observations off-road for indices to be calculated. We concluded that plots placed on lightly used dirt roads in similar habitats permit indices to be calculated that allow the best inferences on animal populations.

Discussion

The PTI, being based on counting daily movements of animals across tracking stations, is unlikely to influence normal animal behavior. We found no track evidence that the species we monitored in the U.S.A. and Australia avoided tracking plots. An advantage of a passive tracking plot is that it can detect less common or neophobic species (or individuals) and simultaneously can capture (observe) a suite of wildlife species using a relatively simple, yet sensitive, method. Table 1 summarizes the diversity of species monitored in Queensland, Australia and Texas, U.S.A. by calculating index values. Had we considered targeting them as well as the mammals, we could have produced indices for a number of bird species in both Australia and Texas (Table 2) (we even contemplated applications for monitoring illegal immigration into Texas from Mexico (Engeman *et al.* 2000)). To detect presence or to index populations with alternative methods could require a major effort using perhaps a combination of methods such as pitfall trapping, spotlight counts, pellet or scat counts, line transect counts or aerial surveys.

An obvious question in the PTI approach is how well species' tracking rates relate to abundance. Several factors affect activity at tracking plots other than population density. However, Bider (1968), in a comprehensive study that produced 182 000 observations in sand transects, evaluated population density as the most important factor affecting activity on tracking plots. He showed seasonal activity related to reproduction, seasonal differences in food availability, seasonal migration, dispersal of young, and of lesser importance, weather at the time of assessment and climatic events may influence activity and affect the index of abundance. While seasonal changes in activity do not necessarily compromise the value of the index, studies which involve comparisons of treatment effect based

Table 1. Mammals successfully monitored with the passive tracking plot index in Queensland, Australia and Texas, U.S.A.

<i>Queensland</i>	
Dingo	<i>Canis lupus dingo</i>
Macropods	Family <i>Macropodidae</i>
Fat-tailed dunnarts	<i>Sminthopsis crassicaudata</i>
Feral cats	<i>Felis catus</i>
Brush-tailed possums	<i>Trichosurus vulpecula</i>
Rabbits	<i>Oryctolagus cuniculus</i>
Rodents	Order <i>Rodentia</i>
Feral pigs	<i>Sus scrofa</i>
<i>Texas</i>	
Coyote	<i>Canis latrans</i>
Bobcat	<i>Felis rufus</i>
White-tailed deer	<i>Odocoileus hemionus</i>
Rodents	Order <i>Rodentia</i>
Rabbits	Family <i>Leporidae</i>
Javelina	<i>Tayassu tajacu</i>
Feral pigs	<i>Sus scrofa</i>
Raccoon	<i>Procyon lotor</i>

Table 2. Birds that we could have targeted for indexing with the passive tracking plot index in Queensland, Australia and Texas, U.S.A.

<i>Queensland</i>	
Emu	<i>Dromaius novaehollandiae</i>
Bustard	<i>Ardeotis australis</i>
Bush thick-knee	<i>Burhinus grallarius</i>
Cranes	<i>Grus</i> spp.
Crows/ravens	<i>Corvidae</i>
Doves	<i>Columbidae</i>
Parrots	<i>Psittacidae</i>
Lapwings	<i>Charadriidae</i>
<i>Texas</i>	
Roadrunners	<i>Geococcyx californianus</i>
Quail (primarily scaled quail)	<i>Callipepla squamata</i>

on population responses should be made during comparable seasons.

Because the PTI is an indirect measure of animal abundance, inferences about changes in index values are best made with an understanding of the system being observed. Earlier we saw how an increase in PTI for bobcats actually was not an increase, and a decrease for white-tailed deer did not represent a true decrease in populations. However, understanding the system not only prevented false inferences, but also allowed the PTI to provide additional insight about the interactions and behaviors of the animals monitored in addition to coyotes.

While the PTI produces few methodology-induced changes to animal behavior that might influence results,

the daily inspection of tracking plots encompasses a time aspect that some assessment methods do not reflect. Methods can be sensitive to the time of day at which they are conducted, relative to each species' peak period of activity. Different species may be active at different times of day, and these peaks may be influenced by events such as cloud cover, temperature, wind speed, etc. (Bider 1968). The methods used to assess population abundance can have profound effects on species behavior or activity, resulting in biased results. This is well documented for line transect observations (e.g., Burnham *et al.* 1980) and is further validated by other examples such as feral pigs acting dead during aerial surveys for helicopter-shot pigs (Saunders & Bryant 1988). Caughley (1977) further discusses how individual and species behavior relative to trapping devices and survey methods affects data quality.

The PTI relies on the detection and correct identification of spoor left on the plots and the ability to distinguish the number of individual intrusions within a plot. Spoor might be missed if the tracking plot is inadequately prepared or if the observers are not trained. Rain, wind and traffic might further obscure or obliterate tracks. Although we have experienced no problems with superimposed tracks when more than one animal crossed the plots, this could pose a problem for monitoring some species in some situations. Loss of information cannot be prevented entirely, but careful attention to plot preparation reduces the loss of data. The loss of some data do not seriously affect calculations of the index and its variance, as each species' index is averaged over many stations and over multiple days.

Implementation of the PTI defines a data structure which is described by a linear mixed model and permits calculation of its variance. This facilitates calculation of confidence intervals and use of hypothesis tests. The variance components calculated for use in the variance formula also provide the investigator with helpful information for planning future studies (e.g., Searle *et al.* 1992), as the relative contributions of plot-to-plot variation and day-to-day variation can be examined to optimize the combination of days and plots.

That the PTI has successfully been used to monitor (simultaneously) multiple species of animals on both continents implies the potential for much broader application than for monitoring wild canids. Based on the success with which white-tailed deer were monitored during the coyote trap tests in Texas, the index is now being applied specifically to target white-tailed deer populations damaging corn in Iowa. Another potential

application relates to deer hunting, which is big business in the part of Texas where our studies took place. Landowners could use the index to track deer abundance to make management decisions regarding the optimal number of hunters to allow each season. Raccoon populations, which were monitored with the PTI in Texas, recently have suffered a rabies epidemic along the east coast of the U.S. (Winkler & Jenkins 1991), and relative abundance could be monitored to plan delivery of oral vaccines in baits (Linhart *et al.* 1991). Raccoons are also major predators of sea turtle nests (Bergh 1999; Stancyk 1995), and populations could be indexed to evaluate the necessity, timing and efficacy of management actions. Research is currently underway at a national wildlife refuge and a state park in Florida where the PTI is being used to monitor activity of raccoons and armadillos along a turtle nesting beach. The role of the index is expanded there because the information is being used to optimize timing of control, measure efficacy of control, and identify locations for placement of control devices (Engeman *et al.* accepted). Feral swine have caused habitat and conservation problems worldwide, and the PTI could be used to assist managers in controlling swine populations. It also was applied in another Florida state park to monitor the feral swine causing significant habitat destruction. The PTI is now incorporated in a quarterly monitoring program to determine the necessity for control, efficacy of control and rates of re-invasion, locations of control devices, and swine spatial distribution patterns (Engeman unpublished data).

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